BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D.C. 20036

SUBJECT: A Lunar Landing Mission to a Mare Ridge - Case 340

DATE: February 14, 1968

FROM: M. T. Yates

ABSTRACT

In order to formalize the scientific and operational advances that are expected to occur throughout a nominal lunar exploration program, it is desirable to have first approximation mission plans to use as a baseline. In this study the results that can be expected, utilizing basic Apollo capability, from a proposed third lunar landing mission (LLM-3) are considered in terms of a specific site and some conservative assumptions. Using less conservative assumptions, the results could apply to LLM-2.

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MEMORANDUM FOR FILE

I. INTRODUCTION

In order to formalize the scientific and operational advances that are expected to occur throughout a nominal lunar exploration program (Ref. 1), it is desirable to have first approximation mission plans to use as a baseline. In this study the results that can be expected, utilizing basic Apollo capability, from a proposed third lunar landing mission (LLM-3) are considered in terms of a specific site and some conservative assumptions. Using less conservative assumptions, the results could apply to a second mission, LLM-2.

No attempt was made to incorporate the effects of real time mission control or alternate timelines based on decision points. It is recognized that these detailed considerations would greatly increase the versatility, and hence, the possible scientific return of the mission.

II. ASSUMPTIONS

In general, the mission plan is based upon present Apollo capabilities and ground rules. The one exception is that the redesignation capability (presumably tested in LLM-2) is used to land within $\sim$100 m of a preselected spot. The use of LM fuel reserves to do this must be justified by the experience of previous missions.

Stay time: A 35 hour lunar stay time is assumed with 3 EVA's and both astronauts out simultaneously. An EVA is assumed to be 3 hours long from exit to ingress. Based on present estimates of oxygen consumption, this leaves a one hour safety margin.

Mobility: All traveling is on foot at a nominal rate of 3 km/hr. A constraint imposed by the emergency oxygen system is a 1 km radius envelope centered on the LM. This may need to be reduced slightly due to rough terrain expected at the LLM-3 landing site.

Payload: The descent payload will consist essentially of the ALSEP configuration "B", which includes the passive seismic, heat flow, cold cathode gauge, and charged particle experiments. The ascent payload will consist of approximately 50 lbs of rock samples (including the core from one of the heat flow holes), and about 15 lbs of tape and film (the rest of the gross payload of 100 lbs is packing and container weight).

Site: A landing site adjacent to the ridge system seen in Apollo site III P11 (36°W 3°S) was chosen for the purposes of this study. Ridges are a relatively common feature of the maria, and since many tend to run parallel to the lunar grid, a detailed study of one may shed light on the tectonic history of the moon. Alternatively, if they are extrusive in nature, their origin may relate to volcanic activity and differentiation within the moon.

III. OBJECTIVES

The general scientific objective of all Apollo lunar landing missions is to gather geophysical and geologic data on the moon and its environs through the use of emplaced scientific stations (ALSEP) and astronaut mobility and observational capability. Operationally, each mission should increase the Apollo lunar exploration capability by extending exploration techniques and verifying the operation and reliability of the hardware.

Specifically, the objectives of LLM-3 would be: 1) to use the LM redesignation capability by landing to a point, 2) to deploy ALSEP, and 3) to conduct geologic traverses and collect soil and rock samples.

The first objective would be achieved by landing within a .25 km^2 area (∿200 m diameter circle) as opposed to the 99% Apollo landing ellipse of 263 km^2. Figure 1 shows an Orbiter V high resolution picture of the site. The adjacent crater will provide a visual landmark during the terminal descent phase as well as a possible fresh exposure of the mare/ridge contact.

The second and third objectives would be achieved during the 18 man hours of extravehicular time. Table I shows approximate timelines for the three EVA's. In the first EVA the LM checkout is accomplished and ALSEP is deployed. The times listed for completion of these tasks are very crude estimates since, at present, there is little hard data on probable lunar work rates in a suited condition. Previous lunar landings will, of course, allow more exact estimates to be made, especially with regard to drilling rates in the lunar surface. Note that near the end of EVA I and II the feasibility of the primary task in the following EVA is considered. Primarily, this is to provide for real time changes in the mission plan should these tasks appear unsafe or impossible.

EVA's II and III are devoted to sample collecting and geologic traverses as shown on Fig. 2. An Apollo ground rule constrains astronaut "A" (with LM RF link) to remain in line of sight of the LM while "B" must remain in line of sight of "A". Although the proposed traverses were laid out with this constraint in mind, uncertainties in the estimates of slopes and elevations may require proposed traverses to be altered so as not to violate this ground rule.

The first traverse includes an investigation of the west wall of the crater. It should be possible to determine whether this crater postdates the ridge or not. If it does, then the terrace-like structures visible in the crater (Fig. 1) may be caused by extrusive events related to the formation of the ridge. The numerous blocks of ejecta around the crater may provide samples of the ridge material or the mare subsurface.

The second traverse would be mainly a detailed examination of the ridge itself. Astronaut "B" would be responsible for the major part of the exploration since "A" would be limited in mobility due to the communications link constraint. Among the features to be investigated on "B"'s traverse would be the fresh crater near the edge of the ridge which hopefully has exposed fresh ridge material. Probably the most crucial data pertinent to the question of the origin of the ridge would be the composition of the ridge material compared to nearby mare material. Similar compositions would indicate a tectonic or orogenic origin, while significantly different compositions would indicate a magmatic origin.

From the ridge crater, "B" would proceed down a small valley back toward the mare. A faint ground pattern in this region and the pseudo-delta structures, where the valley opens out onto the mare floor, suggest that soil mass movement may have taken place here on a fairly large scale.

It is felt that these timelines represent a realistic set of scientific objectives due to the conservatism built into the estimates of metabolic rates and EVA duration. Also one of the astronauts will probably have had lunar surface experience which should facilitate the initial procedures and his acclimatization to the lunar environment. It should be emphasized again, however, that the actual mission plan must be flexible enough to accommodate active real time support from a scientific, as well as an operational standpoint in order to best utilize the astronauts surface time. The plan presented here is merely to provide some feeling for what can be gained scientifically from short range exploratory traverses on early Apollo missions and to indicate what advantages accrue from utilizing the redesignation and staytime capability of the LM.

M. T. Yates

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Attachments
  Figures 1 and 2
  Table 1

REFERENCES

1. Hinners, N. W., D. B. James, and F. N. Schmidt, A Lunar Exploration Program, Memorandum for File, Bellcomm, Inc., January 5, 1968.

LANDING SITE — LLM 3

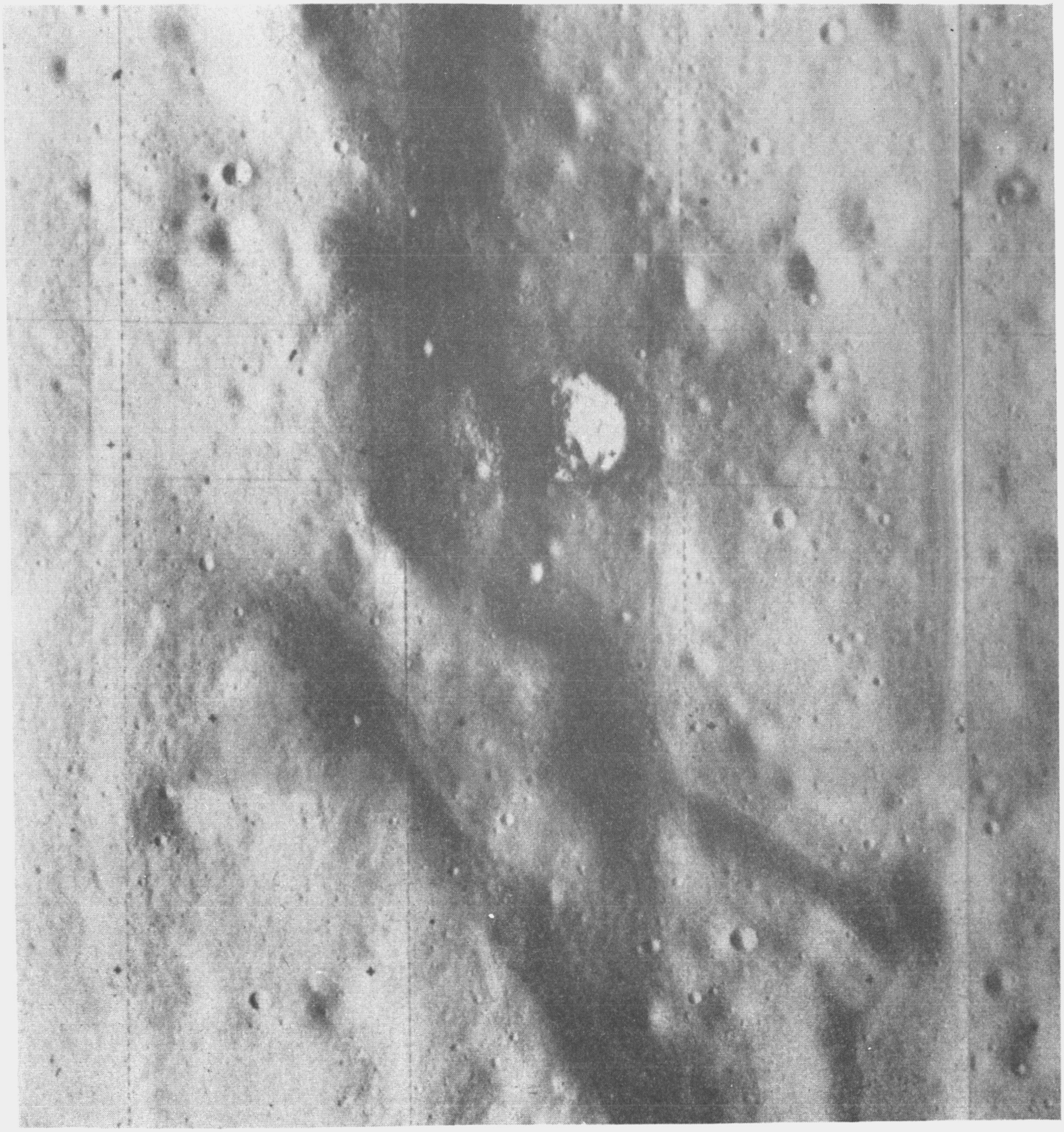

FIGURE 1

GEOLOGIC TRAVERSES — LLM 3

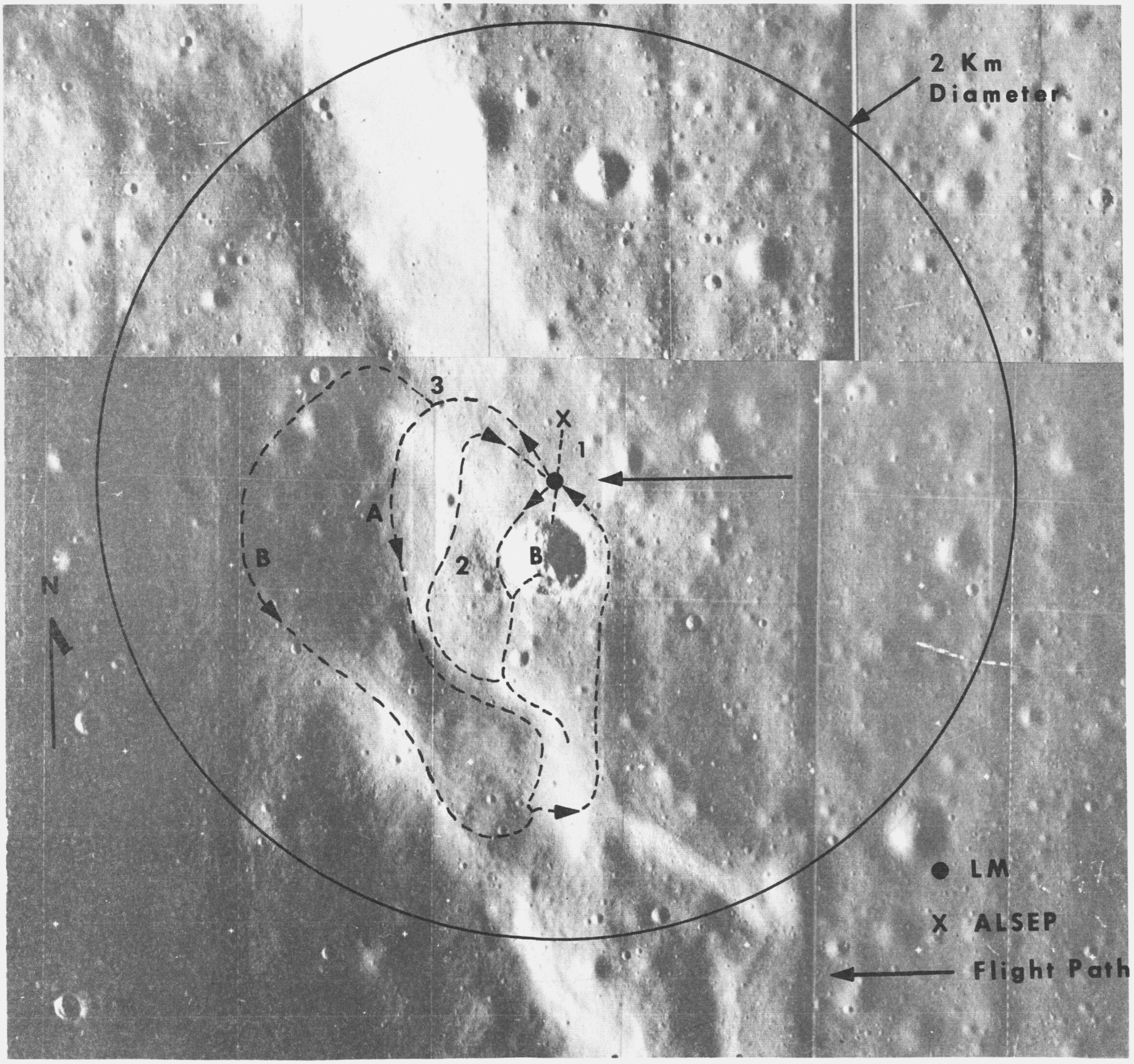

FIGURE 2

TABLE 1

EXTRAVEHICULAR ACTIVITIES TIMELINES

EVA 1

Astronaut "A"	Astronaut "B"	Elapsed Time Hrs.	Min.
LM external inspection and photography - take contingency sample	Determine ALSEP deployment site - locate crater	0	30
Deploy and erect S-band antenna	Open SEQ and remove subpallets	0	50
Fuel RTG and deploy ALSEP		2	30
Proceed to crater and evaluate possibility of descent - return to LM		3	00

EVA 2

Astronaut "A"	Astronaut "B"	Elapsed Time Hrs.	Min.
Proceed along western rim of crater - observe contact with ridge - collect samples		0	30
Monitors progress of "B"	If possible descends into crater-examines wall structure in detail - photograph	1	00
Proceed along edge of ridge - observe nature of contact and sample		1	30
Return to LM along ridge/mare contact - collect samples of ejecta-evaluate possible ascent of ridge		2	30
Stow samples in SRC and reenter LM		3	00

EVA 3

Astronaut "A"	Astronaut "B"	Elapsed Time Hrs.	Min.
If possible, ascend ridge. Photograph ridge slope, crater, LM		0	30
Remains on edge of ridge as communications link	Proceeds onto ridge, locates, samples, and photographs fresh craters in ridge	1	00
Proceeds along edge parallel to "B"	Proceeds down canyon-like structure onto lower terrace of ridge. Observe ridge structures, possible downhill soil movement	2	00
Proceed across mare floor to LM, passing to the east of crater		2	30
Stow samples, film, transfer to cabin. Enter LM		3	00

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